PROPERTY OF
CETON UNIVERSITY LIBRARY
RECEIVED JUN 27 1941

SW

The PSYCHOLOGICAL RECORD . . . .

JUNE, 1941
Vol. IV No. 21

MOTOR FUNCTION IN THE MENTALLY DISORDERED—PART II

WALLACE H. WULFECK

THE PRINCIPIA PRESS, INC.
BLOOMINGTON, INDIANA

Price of this number, 50 cents

MOTOR FUNCTION IN THE MENTALLY DISORDERED

II. THE RELATION OF MUSCLE TENSION TO THE PERFORMANCE OF MOTOR TASKS[1]

By WALLACE H. WULFECK
The Psychological Corporation

INTRODUCTION

A state of tension, i.e., the increase in contraction of the whole skeletal musculature, or isolated systems within the total musculature, is a response either to conflict or to stimuli which arouse implicit ideo-motor action. It may act as a primary form of adaptive response. Tension may be viewed as a kind of readiness or preparation for the more discriminatory movements to be selected out of a vast complex of possible modes of response.[2] Individuals have been observed to differ in adaptability and in the direction of their reaction tendencies, hence their tensional levels and degree of tensional change may be suspected of having transmitted in part the change to the higher behavioral plane. Johnson (13) has advanced the theory that "temperamental differences are indicated by differences of tension . . .". Or, to view it in another way, personality types are believed to show patterns of tension characteristic of the type. Duffey (5, 6) has observed a correlation between the height and shape of the tension line

[1] The second of a series of three studies presented to the faculty of the graduate school of Yale University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Psychology, 1938. The writer wishes to express his appreciation to Professor Walter R. Miles under whose direction this study was carried out.

[2] Muscular tension as here defined should not be confused with muscle tonus which is a postural reflex. The function of tonus, according to Sherrington (16, p. 305), is that of ". . . counteracting gravity for the preservation of an habitual pose of the animal."

with certain general reaction tendencies of the individual which are related to his temperamental characteristics. She believes that increase in tension is definitely correlated with the tendency to become excited, and associated this type of excitation with striving and/or effort. (She describes personalities as excitable or phlegmatic.) The same kind of reasoning was employed by McKinley and Berkwitz (15) in an earlier study of muscle tonus. They point out that normal persons fall into two general classes as regards their muscle tonus, the phlegmatic who show relatively little variation, and the excitable who show marked fluctuations in tonus. Many persons are said to fall somewhere between the two groups.

Jacobson (12) holds that hypertension is related to excitability of the nervous system. Those who are more tense, he believes, are mentally maladjusted, and those who habitually relax all unnecessary muscles are mentally healthy. Thus, the psychotic and psychopathic personality patterns are coincident with tenseness.

In a study on intra-individual consistency of motor function, Allport and Vernon (1) have found that normal subjects maintain a high degree of consistency in tension levels from session to session, i.e., the habitual tension level appears to be characteristic of the personality.

To bring this discussion to a sharper focus, the work of experimentalists who have investigated the interrelationships of certain reaction tendencies and tension, and those investigating specific adaptive activities and tension, should be examined for evidence bearing upon the point. Halverson (9) studying infant sucking and tension, infers that increase in body tension serves as a means of maintaining a kind of balance or equilibrium in the organism when one set or system of muscles is called upon to perform. Increase in the activity of a particular muscle system is generally accompanied by increase in tension throughout the skeletal structure. The equilibrium thus established tends to facilitate the functioning of the particular group of muscles involved in the execution and completion of the act.

The influence of muscular tension on the efficiency of various kinds of mental work has been reported by a number of investigators. Bills (2, 3), Stauffacher (17), and Golla and Antino-

vitch (8), agree that increase in muscle tension increases the efficiency of mental work. The results of their work are not to be regarded as conclusive in the face of the work of Zartman and Cason (22) who report a negative relationship between muscular tension and mental efficiency.

Emotional factors appear to be correlated with tension in a positive way. In two studies, Duffey (5, 6) has demonstrated a definite relationship between excitability and tension. She holds that degree of muscular tension is a very obvious index of the degree of emotional excitation and a consequent dynamogenic effect. Other much needed work is lacking in support or refutation of this important finding.

In the motor realm, Russell (19) studied "the relative efficiency of relaxation and tension in performing an act of skill" by requiring subjects to toss a tennis ball at a target under three conditions of tension for the arm. He found an inverse relation between accuracy and degree of tension. Chase (4) showed that children, having scored a former success on a motivation dynamometer, work under greater tension after failure than under conditions of success.

The burden of the evidence favors the contention that tension is a characteristic condition of the individual, which subserves the performance of adaptive acts, but it is not clear that it facilitates the expression of all types of adaptive behavior.[1]

Because of the universality of this phenomenon, it is somewhat surprising that experimental investigation of the relationship of tension to conditions of psychopathology has been neglected. Jacobsen (12) makes only casual references to the problem, and other experimental reports have not been found. If, as it seems, personality type has its counterpart in consistent tension patterns, then, on the basis of the theories which hold diagnostic mental disease types to be related to personality, for example, the Kretchmerians, it is theoretically possible to demonstrate tension scores which are characteristic of the various types of psychoses and psychoneuroses.

[1] For a discussion of the physiology of tension and related action currents, see the work of Stetson and Bauman (18).

The Problem

Interest in the problem of motor function in the mentally disordered led directly into the exploratory investigation of muscle tension, particularly, since the evidence points to a relationship of interaction between the two factors. Clinical observations foster the suspicion of tensional diversity between normals and psychopaths, and between the various types of mental disorders as well. Moreover, it was demonstrated in an earlier report (20) that mental disorder produces changes in the adaptive acts of the individual as represented by motor performance at the levels of the intermediate integrations.

Should clear cut differences in tension be established, the result might lead to a better understanding of the various types of mental disease, or at least provide some clues for further investigation of the ways in which the disease process affects the behavior of the individual. At any rate, the body of knowledge concerning the symptomatic conditions of mental patients should be appreciably increased, and the course of future experimentation suggested. Plans for an investigation of motor function having been completed, it was a simple matter to augment the procedure sufficiently to get the additional data for this study.

Answers to two questions were sought in this experimental program. (1) Does the psychotic patient show differential manifestations of tension when compared with (a) the psychoneurotic and (b) the normal under conditions of motor task performance? (2) If tensional differences are demonstrated, are they modified by the performance of motor tasks varying in degree of complexity? It will be shown that both questions may be answered in the affirmative.

Subjects, Apparatus and Procedure

Subjects: A total of 123 subjects, white, male adults, of whom there were 50 normals, 23 schizophrenics, 25 manic-depressives and 25 psychoneurotics were used in this investigation. Complete description of the subject population, criteria of selection, etc., will be found in the first paper of this series (20).

Apparatus: Johnson (13) has pointed out that, "If tension is

present it is most likely to be found in the muscles of the hand or in the vocal muscles". Duffey (5, 6) and Halverson (9), have found that satisfactory measures of tension are obtained from the muscles of the hand. Due to its ready application for use with patients whose behavior is apt to be unpredictable, this method of investigating tension was adopted.

Apparatus for use with the hand can be kept at the point of utmost simplicity, portability and sensitivity.

In meeting these criteria, a simple air-tight system was devised. The system was composed of a soft rubber bulb 8.5 cm. x 5 cm. connected by a 1 cm. rubber tube to the recording instrument known as a Pneumodeike. The designers of the Pneumodeike, Hudgins and Stetson, have described the instrument in another place (10). For the purpose of this experiment, the instrument was somewhat modified for waxed paper recording. The amplifying system was removed and a stylus, made of a 2 mm. brass rod and 14 cm. long, was pivoted at a fixed point behind the bellows. Seven cm. from the pivot the stylus was attached directly to the center of the free side of the bellows. Any change in the position of the air content in the system caused the free side of the bellows to change its position with relation to the fixed point. This motion was transmitted to the stylus, slightly amplified at the writing point and recorded on waxed paper.

The chief technical problem to be faced was the possibility of low sensitivity due to the inertia created by the friction of the stylus on the waxed paper. Calibration of the device, adjusted and in position for recording, by means of a mercury manometer, introduced into the system proved this factor to operate at a minimum for the relatively gross measures being made. Calibration was made at the beginning, in the middle, and toward the end of the experiment. The relations were found to be constant for all three calibrations.[1] The instrument was capable of recording depressions of the surface of the bulb as fine as 1 mm. and as

[1] At the end of the experiment a second type of calibration was made. Known weights were applied to the surface of the bulb in such a manner as to simulate the finger pressure. This method takes into account the resistance of the bulb as well as displacement of air within the system. Two mm. of deflection were found to equal 100 grams pressure. The relation was found to be constant for weights up to 1000 grams.

large as 30 mm. The bulbs were made of rubber of a thickness great enough to offer a slight resistance to pressure and of a natural period fast enough for response to movements of relaxation of the pressure. Although the system was capable of rapid recovery, these movements were always relatively slow and smooth so that the responding speed of the bulb was never taxed to its limit.

Procedure: Subjects were tested during three sessions on consecutive days, at the same time of day. The preferred hand was occupied with the performance of one of the following four motor tasks: (1) Pneumoergographic work, (2) following a rhythmic pattern of sound stimuli by tapping a key, (3) simple forward star-tracing, and (4) a test of reaction-coordination by the Miles technique. The order in which the tests have been mentioned is conceived to be the order of complexity of coordinations necessary to perform the test. Tests, apparatus and procedures have been described in detail in another place (20).

At the beginning of each session and before the instructions for the execution of the various tests were given, the subject was instructed to occupy his unengaged hand by holding and gently depressing the tension bulb to an amount most comfortable to him. He was told that he should not be aware of any muscular strain in his hand while doing this. The bulb was held against the palmar surface of the hand with the ends of the four fingers depressing its surface. The thumb was held in a comfortable position overlapping the finger nail of the index finger. In order to avoid the possibility of increased tension in the arm being expressed by pressure of the forearm against the surface of the table, the subject rested his hand in his lap. During the interval between the tests, the bulb was placed on the table.

One of the necessary measures in the experiment was the amount of tension expressed by the subject in squeezing the bulb when not performing a test, i.e., when he was seated quietly. A certain amount of anticipatory tension behavior was probably reflected in the preliminary pressures so recorded due to the novelty of the situation. But this could not be controlled except as the subject was made to feel at ease. Objectively the situation was the same for all subjects.

During this preliminary period a record of the assumed pressure was taken. This record served two purposes, (1) the line so registered was used as a base from which the bi-directional changes in tension were measured, (2) this adopted pressure was regarded as the probable level of the habitual tension of the individual. The means of the pressures for each subject during three sessions was used as the index of habitual tension present in this experimental situation. The values expressing the degree of pressure on the bulb were measured in mm. of deflection of the stylus point from the rest position of the instrument.

Direct measurement and interpretation of the oscillations of the tension line in millimeters of change was accomplished by means of the oscillometer. This instrument was designed by Hull (11) for the purpose of summating the oscillations of a line. Oscillations of the tension line were measured in two directions, supplying data on the actual amount of increase and relaxation of tension.

A second possible method of measurement of tension changes would be to count the number of changes or shifts in direction of the recording point of the instrument. This was not done for two reasons: (1) tensional changes were in general not abrupt shifts but were smooth, gradual relaxations or increases in pressure often imperceptible as an instantaneous change and were therefore not countable. Numerical tabulation of the number of changes in tension would be both interesting and valuable if secured on an apparatus capable of exceedingly fine measurement. However, such minute changes might easily be confused with tremor phenomena. (2) The amount of relaxation or increase in tension, even though it was at times expressed by alternations, provides a truer picture of the tensional situation in terms of the relative amount of expressed tension.

Results and Discussion

Results: Once the base line was established, i.e., the point to which the subject depressed and endeavored to hold the bulb before participating in a given session, tensional changes occurred in two directions. Four possibilities of measurement are present, (1) where no changes occurred, (2) where relaxation or decrease in tension occurred, (3) where increase in tension is shown, and

(4) where alternations between increase and decrease in pressure occurred. In no case, normal or patient, did the subjects fail to register some shift in gripping pressure on the bulb.

The first point of comparison may be made by examining Table 1, showing the data of the distribution of the means for habitual base line tension.[1] Manic patients adopted a position of deeper initial depression on the bulb than on any other group. Their mean value was 19.46 mm. of deflection. The base adopted by the schizophrenics gave a mean of 17.97 mm., for the depressives the mean equalled 15.13 mm. and the normals and psychoneurotics at mean 13.17 mm. and mean 13.44 mm. respectively. The critical ratios ($D/\sigma D$) (Table 3) were statistically reliable for all mean differences except between normals and psychoneurotics, and schizophrenics and manics.

Examination of the range is interesting in that the normals are shown to have the widest range, depressives the narrowest. The minimal base recorded was by a normal who depressed the bulb at 9.33 mm. of deflection. The lowest manic at 13 mm. and the lowest schizophrenic at 14 mm. The maximal base depression occurred in a manic giving 26.33 mm. The highest schizophrenic 25 mm., the highest normal 23.33 mm.

Psychoneurotics were most variable in assuming a base. The coefficient of variability equalled 24.93 as against the depressives who were least variable with a coefficient of 10.71. Among the psychotic groups the manics were most variable, schizophrenics next and the depressives last. Normals were more variable than the depressives and the schizophrenics.

From Table 2, it will be noted that the intercorrelations between the base scores and tension scores are very low, indicating that these two are relatively independent variables. Intersession correlations for the base line are fairly reliable for the four groups with the exception of the manic-depressive group taken as a whole (Table 4).

[1] Measures are given in mm. of deflection recorded by the stylus point. These values are readily interpreted and have as much meaning as they would if translated into grams of pressure. One mm. of deflection is equal to 8.72 grams pressure measured by a mercury column manometer introduced into the system. In terms of known weights applied to the surface of the bulb, 2 mm. of deflection equal 100 grams pressure.

TABLE 1

BASE PRESSURE ON BULB
DATA OF THE DISTRIBUTION OF THE MEAN TENSION (FOR THREE SESSIONS)
(IN MM.)

Group	N.	Maximum	Minimum	Range	Mean σm	S.D. σs.d.	V.
Normals	50	23.33	9.33	14.00	13.17± .40	2.89± .29	21.94
Schizophrenics	23	25.00	14.00	11.00	17.97± .68	3.19± .47	17.75
Manic-Depressives	25	26.33	13.00	13.33	16.52± .72	3.51± .50	21.25
(a) Manics	8	26.33	13.00	13.33	19.46±1.65	4.36±1.09	22.40
(b) Depressives	17	17.33	13.33	4.00	15.13± .41	1.62± .28	10.71
Psychoneurotics	25	22.33	10.00	12.33	13.44± .68	3.35± .47	24.93

TABLE 2

INTERCORRELATIONS TENSION SCORES

NORMAL GROUP

(Pearson Product Moment Coefficients of Correlation. All Values are Positive)

	Tension Increase	Tension Decrease	Base
Total Tension	.99±.002	.99±.002	.16±.09
Increase Tension	——	.98±.004	.14±.09
Decrease Tension		——	.18±.09

Comparing the groups for quantitative tensional changes, certain fundamental divergencies are at once apparent from the following data. Preliminary to this discussion, it should be observed that the three intercorrelations of the means of the three sessions, between the amount of increase and the amount of decrease in tension and total amount of tension shown by normal subjects, are close to a perfect positive correlation (Table 2).[1] Test-retest, i.e., session to session, correlations (Table 4) are quite reliable for the normal group, but show much less reliability for all the other groups. The tensional function appears to be relatively consistent in normal subjects from day to day, but less consistent in the patient groups. The psychoneurotics are indicated as the least consistent. The problem of intra-individual consistency will be discussed at greater length in another place (21).

In terms of total amount of tension, it so happens that the normal group shows the least amount of tension, mean = 18.67 mm. (Table 5). With the lowest mean base score and the least amount of change, it could be predicted that this group would probably show a decrease in tension. This is true, but by no means did they show the greatest amount of decrease (Table 7). Another fact of importance should be noted; namely, that the normals recorded a reduction in tension at the second session and tended to retain this reduced state in the third session. This is to be expected on the basis of two facts: (1) The situation and the tests were now familiar, and (2) a certain amount of learning on the

[1] "Total tension" refers to the summation of the increases and decreases in pressure on the bulb during a single session.

TABLE 3

RELIABILITY OF THE DIFFERENCES ($\frac{D}{\sigma D}$) BETWEEN MEANS OF THE MEANS OF THE FOUR GROUPS IN TENSION SCORES

	Normals & Schizophrenics	Normals & Manic-Depressives	Normals & Manics	Normals & Depressives	Normals & Psychoneurotics
Tension Increase	3.20	2.14	1.04	2.06	.07
Tension Decrease	1.47	.58	.30	.04	.24
Tension Total	2.35	.92	.29	.97	.14
Base	6.08	4.06	3.70	3.40	.34
	Schizophrenics & Manic-Depressives	Schizophrenics & Manics	Schizophrenics & Depressives	Schizophrenics & Psychoneurotics	
Tension Increase	1.26	1.38	.92	2.90	
Tension Decrease	1.36	1.16	1.05	1.13	
Tension Total	1.30	1.27	.98	2.01	
Base	1.46	.84	3.59	4.72	
	Manics & Depressives	Manics & Psychoneurotics	Depressives & Psychoneurotics	Manic-Depressive & Psychoneurotic	
Tension Increase	.57	.94	1.85	1.86	
Tension Decrease	.29	.40	.10	.27	
Tension Total	.42	.19	.79	.71	
Base	2.55	3.36	2.14	3.11	

TABLE 4

COEFFICIENTS OF RELIABILITY—TEST-RETEST
MEANS OF SESSION II
MEANS OF SESSION III

(Pearson Product Moment Coefficient of Correlation. All Values are Positive)

Tests	Normals	Schizophrenics	Manic-Depressives	Psycho-neurotics
N.	50	23	25	25
Tension Increase	.85±.03	.54±.10	.65±.08	.35±.12
Tension Decrease	.87±.02	.45±.11	.64±.08	.39±.11
Total changes in tension	.87±.02	.50±.10	.61±.08	.40±.11
Base	.87±.03	.81±.05	.58±.09	.75±.06

motor tests had taken place during the first session. Habituation and learning tend to be accompanied by a reduction in tension. See, for example, Bills (3).

Inasmuch as the normal subjects gave this rather regular type of result, comparison of the patient groups with them is somewhat simplified. Taking the most extreme deviations first, it may be seen from Tables 5, 6, 7 that the schizophrenic group shows the greatest amount of tension. The mean of their total amount of tension recorded equalled 28.64 mm., increase scores mean equalled 15.46 mm., decrease scores mean equalled 13.17 mm. The critical ratios ($D/\sigma D$) (Table 3) of the differences between their scores and the normals indicate better than 99 chances in 100 that the total differences are reliable, complete reliability for the increase scores, and 93 chances in 100 that the decrease score differences are reliable. The schizophrenics differed markedly from the other patient groups as well.

Another unique finding in these data is that session to session scores show a consistent, day to day, increase in the amount of tension present in the individual with schizophrenia. Instead of familiarity and learning factors operating to reduce tension in these patients, they recorded greater increases in tension each time they participated in the test situation. It might be argued that failure of the patients to understand the instructions given them could account for increased tension. This criticism is answered by the finding of greater tension scores with increasing familiarity with the tests.

TABLE 5

TOTAL TENSION
DATA OF THE DISTRIBUTION OF THE MEANS
FOR VARIOUS GROUPS FOR THREE SESSIONS
(IN MM.)

Group	N.	Maximum	Minimum	Range	Mean σm	S.D. σs.d.	V.
Normals	50	83.85	2.58	81.27	18.67±2.24	15.82±1.88	84.73
Schizophrenics	23	89.27	9.45	79.82	28.64±3.62	16.96±2.50	59.22
Manic-Depressives	25	85.65	5.83	79.82	22.33±3.26	15.93±2.25	71.34
(a) Manics	8	51.83	5.83	46.00	20.38±5.38	14.25±3.56	69.92
(b) Depressives	17	51.83	8.93	42.90	23.24±4.15	16.58±2.84	71.34
Psychoneurotics	25	66.55	3.45	63.10	19.18±3.02	14.77±2.09	77.01

TABLE 6

DATA OF THE DISTRIBUTION OF THE MEANS—AMOUNT OF TENSION INCREASE FOR VARIOUS GROUPS FOR THREE SESSIONS (IN MM.)

Group	N.	Maximum	Minimum	Range	Mean σm	S.D. σs.d.	V.
Normals	50	39.68	.97	38.71	8.52±1.06	7.52± .75	88.26
Schizophrenics	23	47.17	5.58	41.59	15.46±1.90	8.91±1.31	57.67
Manic-Depressives	25	42.65	4.23	38.42	12.43±1.49	7.27±1.03	58.49
(a) Manics	8	24.65	4.23	20.42	11.24±2.40	6.35±1.59	56.49
(b) Depressives	17	42.65	5.80	36.85	12.99±1.89	7.54±1.29	58.04
Psychoneurotics	25	31.33	1.67	29.66	8.65±1.38	6.75± .95	78.03

TABLE 7

DATA OF THE DISTRIBUTION OF THE MEANS—AMOUNT OF TENSION DECREASE FOR VARIOUS GROUPS FOR THREE SESSIONS (IN MM.)

Group	N.	Maximum	Minimum	Range	Mean σm	S.D. σs.d.	V.
Normals	50	44.17	1.28	42.89	10.14±1.24	8.74±0.87	86.19
Schizophrenics	23	42.10	3.87	38.23	13.17±1.65	7.75±1.14	58.85
Manic-Depressives	25	43.00	1.50	41.50	9.90±1.74	8.50±1.20	85.86
(a) Manics	8	27.18	1.50	25.68	9.14±3.06	8.10±2.03	88.62
(b) Depressives	17	43.00	3.13	39.87	10.25±2.24	8.94±1.53	87.20
Psychoneurotics	25	35.22	1.78	33.44	10.54±1.64	8.02±1.13	76.09

Turning now to a consideration of the manic-depressive group, it will be observed that there are marked dissimilarities in results when set against the normal performance, although they are not so extreme as the schizophrenic deviations. From Table 5 it will be found that the mean total tension score was 20.38 mm. for the manics, 23.24 mm. for the depressives and 22.33 mm. for the combined group, all of them higher than the scores for the normals and psychoneurotics.

It may be seen that both the manics and the depressives were more tense on the second day than on the first, but on the third day tended to approximate the tension level indicated on the first day. Thus it appears that these patients were less quickly adapted to the situation than the normals, but that an adaptive process was present seems clear from these data. Just what the result of a longer series of sessions would bring forth can only be imagined, but it seems probable that these patients might show a relative consistency about the mean of their first session tension level.

As in the case of the performance of motor tasks reported in an earlier paper (20), the psychoneurotic group show no significant discrepancy in tension scores when compared with normals. The only point at which they deviate lies in a slight increase in tension from session to session, whereas the normals appeared less tense from day to day. The difference, however, was not reliable (Table 3). If, as Jacobson (12) insists, there is an increase in tension whenever mental maladjustment is present, it must manifest itself in the psychoneurotic within limited areas of his action or behavior. For, if these data have any value, there is at least one area of experience, i.e., the motor, in which tension scores are commensurate with those of normal subjects.

Variability, as measured by the coefficient of variability, is seen to be highest for the normal subjects and lowest for the schizophrenics. Psychoneurotics are more variable than the manic-depressives.

Turing to the second aspect of the investigation, the data must be examined for the answer to the question regarding the possibility of tension being altered by the subject's performance on disparate motor tasks, i.e., do motor tasks involving greater speed

and coordination make greater tension demands on the organism?

Data on separate tension scores for the four motor tasks are presented in Table 8. Reference to the table shows at once that the various groups tend to maintain their relative positions with regard to the total amount of tension throughout all tests, as was to be expected from previous data. It is also clear that total tension scores are not significantly different for (1) pneumo-ergographic work, (2) the following of patterns of rhythm and, (3) simple star-tracing. But when the subjects performed the more complex reaction-coordination test, there developed a striking increase in tension for all subject groups. Had it been possible for subjects to know their success or failure in these tasks, this factor might account for the differences, but this was objectively impossible, although it may have entered as a subjective factor. The difference must be caused by other factors. The lack of correspondence in degree of complexity between this test and the three others is evident when the component movements are analyzed for complexity. In this test speed is the essential skill; accuracy of aiming and of movement, while important, are secondary factors. Moreover, the motivational element is high due to the sound and rapid movement of the hand of the Cenco timer. Objectively, the experimenter observed that all subjects appeared to be more highly interested in the test, and at the same time more tense in their performance. It seems perfectly legitimate to assume that this test was of a higher order of complexity than any of the others in the battery.

The assumption may be made, so far as this experiment is concerned, that muscular tension increases as the complexity of the motor task increases, not only for normals but for the mentally diseased as well. One criticism of this assumption should be pointed out, namely, that the increase in tension might be attributed to the high degree of motivation generally aroused by this test. This result is, however, in general agreement with some of the work with normals mentioned in the introduction.

Discussion: Within the limits of the results of this experiment, both of our questions have been answered positively. Psychotic patients register greater amounts of tension change accompanying motor tasks than do normals. Psychoneurotics, however, show dif-

TABLE 8

TENSION SCORES ON FOUR MOTOR TESTS, MEANS FOR THREE TRIALS AND THREE SESSIONS (IN MM.)

	Pneumo-ergograph			Rhythm			Star-Tracing			Reaction-Coordination			Totals Means of Means		
	I	D	T	I	D	T	I	D	T	I	D	T	I	D	T
Normals	7.20	9.72	16.92	6.07	7.37	13.44	6.42	8.19	14.61	14.57	15.50	30.07	34.09	40.57	74.66
Schizophrenics	14.71	11.44	26.13	11.04	9.08	20.12	12.43	6.94	19.37	23.67	21.91	45.58	61.85	52.69	114.51
Manic-Depressives	10.97	9.44	20.41	10.41	7.30	17.71	9.56	6.82	16.38	18.78	16.02	34.80	49.72	39.59	89.31
(a) Manics	9.37	8.37	17.44	11.37	8.15	19.52	7.91	5.57	13.48	16.50	14.82	31.32	44.98	32.31	77.29
(b) Depressives	11.72	9.92	21.64	9.96	6.90	16.86	10.33	7.40	17.73	19.86	16.59	36.45	51.95	43.00	94.95
Psychoneurotics	6.10	8.89	14.99	6.43	7.88	14.31	6.89	8.71	15.60	15.15	16.66	31.81	34.58	42.14	76.72

ferences which are unreliable, i.e., they tend to approximate the tension responses of normal subjects. Easy motor coordinations show low concomitant tensions, difficult motor integrations show higher tensions.

Regarding the agreement of this experiment with the findings of Duffey (5, 6), Bills (2, 3), and others (17, 19), namely, that increased tension is a form of adaptation to increase the motor efficiency of the mechanism, a parallel was found, for normal subjects demonstrate the potency of habituation and learning for decreasing tension. The subject becomes progressively adapted to the situation and task. Not so for the schizophrenic subjects who performed in all tests at a consistently less efficient level than all other groups and gave higher tension scores. It may well be that the state of higher tension and the session to session increase in tension acted as a form of adaptation, but it does not follow that the subjects were adapting to the performance of the immediate task before them in such a way as to increase their efficiency. Although they did show day to day improvement in performance of motor tasks. If they were adapting, and it seems doubtful, the form of adaptation must be some peculiar quality of schizophrenic response mechanisms. These data supply no evidence on which to base a claim for increased "effort" or "striving" to meet the demands of the situation. On the contrary, an objective rating by the experimenter would rank the schizophrenics as showing less of these qualities than the other test groups.

From the direct evidence in this study, it may be said that the habitual base line tension level of schizophrenics is higher than other patient groups and normals. Moreover, greater tensional changes are expressed by the patient group which do not seem to find overt expression in an increased efficiency of performance of motor tasks. Rather, it seems probable that tension tends to pile up within the individual. Whether or not the cumulative effect acts to reduce progressively the adequacy of response is problematical. The problem of the physiological limit of accumulated tension within the organism and its dissipation must be answered by the physiologist in terms of his knowledge of the behavior of action currents, muscle contraction and reflex discharge. Psychologically, this discharge of tension may be observed in the in-

appropriate responses and impulsive acts so characteristic of the schizophrenic. The cumulative effect of tension is to be seen in the extreme catatonic states. From the gross evidence of this immediate experiment, it may be suggested that schizophrenia is a disease in which the basic adaptive response mechanisms of behavior are in some manner disturbed. If, as Duffey (6) contends, habitual differences in tension levels are indicative of a tendency to become aroused or excited with a consequent dynamogenic effect upon the individual, (and this seems to be true for the normal group in this study), then there is some process of inhibition which determines the failure of the schizophrenic to follow the normal course of behavioral adaptation. Further studies of this type directed toward the investigation of inhibition are indicated.

At first glance, the similarity of tension scores for manics and depressives seems confusing because of the striking differences in their overt behavior. We feel that manic hyperactivity and depressive retardation must affect every level of the patient's reaction tendency pattern in a manner peculiar to the visible symptoms. As has been shown in an earlier report (2), there is some evidence for this belief, when efficiency of motor function is compared. But the results of this experiment contradict dissimilarity of tension function between the patients in the two phases. Moreover, the points at which they differ from schizophrenics, psychoneurotics and normals are clearly commensurate.

A sharp increase in tension level is shown between sessions I and II followed by a return to the first day's level in session III. This result suggests, on the one hand, the possibility of a slowing down of the manic-depressives' ability to become habituated to situations demanding accurate performance of a complex kind; or, on the other hand, a day to day variability in his ability to adapt to complex conditions of adjustment.

Because the manics performed motor tasks at a high level of efficiency, the depressives at a low level of efficiency, and although both groups gave comparable tension records, these results contradict the theory that increase in tension is conducive to an increase in efficiency of performance. The theory may hold for normals, but so far as this investigation is concerned, it has little

relevancy when applied to manic-depressives. The manics tend to fit into this description and also to follow Duffey's (6) notion that tension is correlated with excitability, but it certainly does not describe the depressive's retardation. Even in the cases of so-called agitated depression, the term "excitability" can hardly be applied. As a matter of fact, it can be held that the manic releases so much energy in overt activity that he should be less habitually tense than the depressive. This again is a contradiction of one of Duffey's (5, 6) contentions for normals. To be sure, it may be argued that the manic evidences malfunction of energy supply, but it is more probable that the manic has no more energy to expend than the normal or the depressive, the difference lying in the manner and direction of his use of it.

It would appear then, that tension does not subserve the same functions in the psychotic as it does in the normals, or what is more likely, other factors in some way modify its effect upon the adaptivity and performance of the psychotic.

This experiment shows psychoneurotics and normals as closely identical in tension scores, a result which agrees with the findings that the two groups are alike in performance of motor tests. As was suggested elsewhere (20) the psychoneurosis probably affects the patient in a narrow or limited sphere of his experiential life, whereas the psychosis profoundly alters the total reaction patterns of the individual. This study, therefore, bears out the belief that the two types of mental disturbance bear little or no resemblance.

SUMMARY

(1) This is the second in a series of exploratory studies on motor function in the mentally diseased. It was concerned with the investigation and comparison of tension in psychotic, psychoneurotic and normal subjects, during the performance of motor tests.

(2) A total of 123 white, adult male subjects was used. The subjects were divided into the following four groups: 23 schizophrenics, 25 manic-depressives, 25 psycho-neurotics and 50 normals.

(3) During the performance of four motor tests at the intermediate levels of coordination complexity, tension measures were taken from the unengaged hand of the subject.

(4) The method of recording tension on a waxed paper polygraph simultaneously with measures of motor performance, involved the use of a rubber bulb held by the subject and a recording tambour known as the pneumodeike. Records were taken on three trials for each of the four tests during three sessions on consecutive days.

(5) Schizophrenics were found to show marked quantitative differences from the normals. They recorded higher habitual (base line) tension and a more constant increase in tension level from session to session than all other groups tested.

(6) Manic-depressives showed higher habitual (base line) tension than normals, but less than schizophrenics. Their session to session tension level was variable, tending to return on the third day to the level of the first day. Both manics and depressives give closely identical habitual (base line) tension levels and express a comparable variability in tension curves. The pattern for the two phases appears similar. The dissimilarity in mode of expression at the overt level is probably the only significant difference.

(7) Psychoneurotics gave no differential scores from the normals in habitual (base line) tension. Their curves showed a slight, but unreliable increase in tension from session to session, whereas the curve for the normals indicated a decrease in tension from day to day. Contrary to Jacobson's belief that mental maladjustment is always accompanied by increase in tenseness, the psychneurotics were no different than normals in expressed tension. It is suggested that increased tension, if present in the psychoneurotics, must be associated with the limited field of experience in which the psychoneurosis is expressed.

(8) It was found that the more difficult motor coordinations were accompanied by greater tension for all groups.

(9) The suggestion was made that tension acts as a preparatory adaptation for discriminatory motor responses. The more complex the pattern of response demanded by the environ-

ment, the more tension is likely to be manifested by the organism.

(10) Explanations of the function of tension in normal subjects seem not to apply to abnormals. Other factors related to the disease syndrome tend to modify in some manner normal expression of tension in the schizophrenic and other psychotic patients. Further research on tensional inhibition and variability in these subjects is suggested.

(11) From an exploratory point of view, this study opens a number of possibilities for fruitful research in this field.

REFERENCES

(1) Allport, G. W., and Vernon, Philip E., *Studies in expressive movement,* New York; Macmillan, 1933, pp. 269.

(2) Bills, A. G., *The influence of muscular tension on the efficiency of mental work,* Amer. J. Psychol., 1927, 38, 227-251.

(3) Bills, A. G., Tension in learning and association, Proc. IX Internat. Cong. of Psychol., Princeton Psychol. Rev. Co., 1930, pp. 75-76.

(4) Chase, L., Motivation of young children, Univ. of Iowa Studies in Child Welfare, 1932, V, No. 3, pp. 119.

(5) Duffey, E., Tensions and emotional factors in reaction, Genet. Psychol. Monog., 1930, 7, No. 1, pp. 79.

(6) Duffey, E., The measurement of muscular tension as a technique for the study of emotional tendencies, Amer. J. Psychol., 1932, 44, 146-162.

(7) Freeman, G. L., The measurement of tonus by deformation of the tendon, Amer. J. Psychol., 1930, 42, 581-592.

(8) Golla, F. L., and Antinovitch, S., The relation of muscle tonus and the patellar reflex to mental work, J. Ment. Sci., 1929, 75, 234-241.

(9) Halverson, H. M., Infant sucking and tensional behavior. J. Genet. Psychol., 1938, 53, 365-430.

(10) Hudgins, C. V., and Stetson, R. H., A unit for kymograph recording, Science, 1932, 76, pp. 59-60.

(11) Hull, C. L., An instrument for summating the oscillations of a line, J. Exper. Psychol., 1929, 4, 359-361.
(12) Jacobson, E., Progressive relaxation, Chicago: Univ. Chicago Press, 1929, pp. 379.
(13) Johnson, B., Changes in muscular tension in coordinated hand movements. J. Exper. Psychol., 1928, 11, 329-341.
(14) Lewy, F. H., Tonus und bewegung, Berlin: Springer, 1923, pp. 673.
(15) McKinley, J. C., and Berkwitz, N. J., Quantitative studies on human muscle tonus. I. Description of methods, Arch. Neurol. and Psychiat., 1928, 19, 1035-1056.
(16) Sherrington, C. S., The integrative action of the nervous system, New Haven: Yale University Press, 1905, pp. 411.
(17) Stauffacher, J. C., The effect of induced muscular tension upon various phases of the learning process. J. of Exper. Psychol., 1937, 21, 26-46.
(18) Stetson, R. H., and Bouman, H. D., The coordination of simple skilled movements, Arch. Neerlandaises de Physiol. de l'homme et des animaux, XX, 1935.
(19) Russell, J. T., Relative efficiency of relaxation and tension in performing an act of skill, J. Gen. Psychol., 1932, 6, 330-343.
(20) Wulfeck, W. H., Motor function in the mentally diseased. I. A. comparative investigation of motor function in psychotics, psychoneurotics, and normals. Psychol. Rec., 1941, 11, 151-160.
(21) Wulfeck, W. H., Motor function in the mentally diseased. III. Intra-individual consistency of expressive movement in psychotics, psychoneurotics and normals. J. of Psychol. 1941, 11, 151-160.
(22) Zartman, E. N., and Cason, H., The influence of an increase in muscular tension on mental efficiency, J. Exper. Psychol., 1934, 17, 671-679.